

MONTHLY WEATHER REVIEW.

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The MONTHLY WEATHER REVIEW is based on data from about 3500 land stations and many ocean reports from vessels taking the international simultaneous observation at Greenwich noon.

Special acknowledgment is made of the data furnished by the kindness of cooperative observers, and by Prof. R. F. Stupart, Director of the Meteorological Service of the Dominion of Canada; Señor Manuel E. Pastrana, Director of the Central Meteorological and Magnetic Observatory of Mexico; Camilo A. Gonzales, Director-General of Mexican Telegraphs; Capt I. S. Kimball, General Superintendent of the United States Life-Saving Service; Commandant Francisco S. Chaves, Director of the Meteorological Service of the Azores, Ponta Delgada, St. Michaels, Azores; W. N. Shaw, Esq., Secretary, Meteorological Office, London; H. H. Cousins, Chemist, in

charge of the Jamaica Weather Office; Señor Anastasio Alfaro, Director of the National Observatory, San José, Costa Rica; Rev. L. Gangoiti, Director of the Meteorological Observatory of Belen College, Havana, Cuba.

As far as practicable the time of the seventy-fifth meridian, which is exactly five hours behind Greenwich time, is used in the text of the MONTHLY WEATHER REVIEW.

Barometric pressures, both at land stations and on ocean vessels, whether station pressures or sea-level pressures, are reduced, or assumed to be reduced, to standard gravity, as well as corrected for all instrumental peculiarities, so that they express pressure in the standard international system of measures, namely, by the height of an equivalent column of mercury at 32° Fahrenheit, under the standard force, i. e., apparent gravity at sea level and latitude 45°.

SPECIAL ARTICLES, NOTES, AND EXTRACTS.

STUDIES ON THE THERMODYNAMICS OF THE ATMOSPHERE.

By Prof. FRANK H. BIGELOW.

VI.—THE WATERSPOUT SEEN OFF COTTAGE CITY, MASS., IN VINEYARD SOUND, ON AUGUST 19, 1896.¹

THE SOURCES OF THE DATA USED IN THE DISCUSSION.

This waterspout has an especial scientific interest to meteorologists because it was seen under circumstances remarkably advantageous for making observations and photographs, from which it is possible to compute, with much accuracy, the dimensions of the tube, and thus facilitate the application of the mathematical theory of vortices.

A series of papers and letters from various persons who saw the phenomenon, and a very complete set of photographs, were secured at the time by the Editor, which he has courteously placed at my disposal for incorporation in this paper, and they will be found inserted in the following pages. I have myself been familiar with that part of the Massachusetts coast, and have therefore been interested to study the facts as thoroughly as possible as preliminary to the discussion of this type of vortex motion. I accordingly visited Cottage City the following September, and was conducted by Mr. Chamberlain to the spot where he placed his camera for making his photographs. There I made a sufficiently accurate survey of the linear distances between that spot and the telegraph poles shown in his pictures to determine the scale of distances for all objects. Furthermore, by collecting and collating all the data relative to the positions of the waterspout and the schooner seen in the several photographs, I am able to plot them on the Coast and Geodetic Survey Chart No. 112, in such a way as to reconcile nearly all of the statements made regarding the distances and progress of the two objects, respectively. The photographs taken from such distances as Vineyard Haven and Falmouth Heights give an excellent view of the whole cumulonimbus cloud from which the tube descended, and its connection with the thunderstorm which preceded it. All these data will enable us to discuss the subject of tornado and waterspout formation with considerable fulness, and with the conviction that confidence may be placed in the comparison of the observations and computations. There is every reason to believe that the photographs are perfectly genuine, and free from

touches to add to their artistic beauty at the expense of scientific accuracy. Certain preliminary computations were made in 1897, the result of which was published in the International Cloud Report, page 633, Report of the Chief of the Weather Bureau 1898-99, Volume II; this was republished in the MONTHLY WEATHER REVIEW.² My purpose then was to illustrate the application of certain formulae, and it was my intention at that time to complete the study as soon as my other duties permitted. In these present papers I shall begin with the descriptive accounts of the waterspout, then pass to a discussion of the facts as shown by these reports and the photographs, and finally consider the dynamic motions and the thermodynamic conditions present in the atmosphere near Cottage City on that occasion.

LETTERS AND REPORTS OF OBSERVERS.

The following letters, reports, and observations have been furnished by the several authors. It will be instructive to refer to fig. 25 while reading these papers.

(A) EXTRACT FROM THE DAILY JOURNAL OF U. S. WEATHER BUREAU STATION, VINEYARD HAVEN, MASS., W. W. NEIFERT, OBSERVER.

August 19, 1896.—Partly cloudy weather during the morning, with gentle northerly wind. Three magnificent waterspouts were observed in Vineyard Sound to-day, in northerly direction from station, about ten miles distant. During the entire afternoon the weather was partly cloudy and sultry, with great masses of cumulus clouds in the north and northeast. At 12:45 the first display was observed. At first a long spiral column seemed to fall from the clouds, about the thickness of a man's body, but this gradually increased in size as the cloud lowered, and when it reached the water it was as thick as a large sized cask, and changed in color from a rich gray to a black, and assumed a funnel shape at the base of the clouds. The cloud seemed of a yeasty white where the column came in contact with it, and looked as though the water was hauled up to it. The area of contact appeared small. The spout was very straight and almost perpendicular, kicking up a great sea as it traveled. When it disappeared it began to do so at the base and rapidly reached the top, having the appearance of clouds, and finally cleared away, like steam from an engine, at 12:58 p. m., leaving a clear sky for a background and the original clouds above. At 1 p. m. it formed the second time, which was really the most interesting spectacle of all. From a mass of inky clouds it reached down, finger-like, to almost the ocean's surface. Below it the water was stirred to an angry whirlpool, the foam reaching up perhaps a hundred feet. It appeared as though great volumes of water were traveling up to the cloud by an endless screw, when suddenly, at 1:18 p. m., the long arm disappeared in a manner similar to the first. At 1:20 it formed for a

¹ No. V of the series ("The Horizontal Convection in Cyclones") will follow later.

² May, 1902. Vol. XXX, pp. 257, 258.